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MUNICIPAL WATER NEEDS IN THE PACIFIC NORTHWEST TO THE YEAR 2020

Warren C. Westgarth

Public Health Service
Portland, Oregon

February 1965

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COLUMBIA RIVER BASIN COMPREHENSIVE PROJECT
For Water Supply and Pollution Control

MUNICIPAL WATER NEEDS
IN THE PACIFIC NORTHWEST
TO THE YEAR 2020

FEBRUARY 1965

Prepared by WCW

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U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
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Division of Water Supply and Pollution Control
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This working paper contains preliminary data and information primarily intended for internal use by the Columbia River Basin Project staff and cooperating agencies. The material presented in this paper has not been fully evaluated and should not be considered as final.

ACKNOWLEDGEMENTS

Many people, cities, consulting engineers and agencies have aided in some way with gathering and assimilating the voluminous data used in this study, and they deserve a "thank you" even though they cannot be named individually.

A special acknowledgement is issued to the Water Usage Committee of the Pacific Northwest Section American Water Works Association who allowed the use of their report as a basis for this one.

Other references are listed at the end of the report.

MUNICIPAL WATER NEEDS IN THE PACIFIC NORTHWEST TO THE YEAR 2020

by Warren C. Westgarth, Sanitary Engineer

INTRODUCTION

How much water does City X, with 12,000 inhabitants residing along the Snake River require to satisfy its municipal needs for the month of July of the year 2010? One would need to be clairvoyant to answer this type of question with certainty, and because we cannot foresee the future, it is necessary to make use of past data with its trends, periodicities and eccentricities to help predict reasonable values for the future. In the Columbia River Basin Comprehensive Project the requirement exists for reasonable values of municipal per capita water needs in the Pacific Northwest for the design years from 1960 through 2020. Past data on a national basis were found to be significantly different from Northwest data and would, therefore, not suffice as bases for projecting per capita values in this area. Because of the differences shown by the data at hand, it was necessary to study the Northwest as a separate area in order to derive reasonable projected per capita needs. The derived values in this paper were calculated for use in comprehensive planning and may not fit the requirements of consulting engineers and others who are interested in specific municipalities. Several papers are referenced and some basic data are appended for those who may wish to carry this work further.

Variables that were considered in this study of municipal per capita water needs were:

1. Size of community or service area;

2. General state of the economy including living standards of families, price of water and industrial influences;

3. Trends, periodicities, and eccentricities caused by metering, availability of water, war developments, and other man-made influences;

4. Climatic variations such as rainfall and temperature.

Preliminary investigations indicated that if only metered systems were studied and if major industrial uses were subtracted from municipal values, climatic area and population would be the large remaining variables. The climatic factor is important in the Pacific Northwest because the variation is from a wet coastal region to an arid plateau. The prevailing westerly winds carry

moisture-laden air to the Coastal Range where dynamic cooling precipitates from 60 to over 100 inches of rain in a year. The rainfall lessens on the lee-side of the Coast Range to the order of 45 inches yearly and again increases in the aptly-named Cascades where the high mountains cause considerably cooling with resultant precipitation in the form of both snow and rain. On the lee-side of the Cascades the precipitation drops to less than 20 inches, much of which occurs as snow. This orographic type of rainfall does not occur frequently in the June through October months, and all of these areas can suffer severe drought periods of one to five months. Lawn sprinkling and garden irrigation are necessary adjuncts to other municipal uses and can cause exhorbitant increases to normal averages.

METHOD OF STUDY

The Pacific Northwest area was arbitrarily divided into three climatic designations, with the following general characteristics:

1. Dry summer, winter rain, 20-50 inches/yr. precipitation
2. Arid summer, winter snow, 20 " " "
3. Coastal area

A fourth designation was the Pacific Northwest as a whole region. Data from all sources in each of these categories were studied with respect to population range, average use of water, maximum monthly use, maximum daily use, and unaccounted for water. These were put in terms of gallons per capita per day (gpcd) for the year 1960 and were projected to the years 1980, 1985, 2000, 2010 and 2020 for design purposes.

Basic data accumulated for the studies are appended in brief tabulations. More detailed data are in the files of the Columbia River Basin Comprehensive Project of the U. S. Public Health Service in Portland, Oregon.

PRESENTATION OF RESULTS

Results from a study of this type may be presented in a myriad of ways. In this case it was decided to present the summary table which will be used for design first, and then the explanatory material and substantiating data later.

Table 1 shows the summary of mean values of 1960 use and 1960-2020 needs for each of the above described designations, and for population ranges of less than 10,000, 10,000 to 20,000, greater than 20,000, and a combination of all sizes. The number of cities and the percentage of urban Pacific Northwest (PNW) population that each entry represents are included. Below the main tabulation are listed summaries by other people or organizations with the respective percentage of population represented. It is notable that the present study includes 156 cities and represents 92 percent of the urban PNW population. The mean value of 181 gpcd shown for designation 4 is close to the 187 overall weighted average indicated by all data combined, both of which are significantly in excess of the 143 gpcd indicated by AWWA data and USPHS data as the national average.

TABLE 1

MUNICIPAL WATER USE STUDY

Values in Gallons per Capita per Day (gpcd)
1/ Projections rounded to nearest 5 gpcd

Climatic Designation	Population Range	No. of Cities	% of PNW Urban Pop.	1960 Use	Design Year Need 1/ 1960	1980	1985	2000	2010	2020
1	<10,000	25	3	143	170	195	200	215	225	230
	10-20,000	4	2	177	210	235	240	255	265	270
	>20,000	6	22	173	210	230	240	250	260	270
	All Sizes	35	27	150	180	205	210	225	230	240
2	<10,000	64	6.5	213	255	280	285	300	310	315
	10-20,000	14	6	196	235	260	265	280	290	295
	>20,000	11	14.5	209	250	275	280	295	305	310
	All Sizes	89	27	210	250	275	280	295	305	310
3	<10,000	14	2	130	155	180	185	200	210	215
	10-20,000	6	2	119	145	170	170	190	195	205
	>20,000	12	35	140	170	190	195	210	220	230
	All Sizes	32	39	133	160	185	190	205	210	220
4	<10,000	103	11	186	235	255	260	275	285	295
	10-20,000	24	10	174	210	235	240	255	260	270
	>20,000	29	71	173	210	235	240	255	260	270
	All Sizes	156	92	181	215	240	245	260	270	275
All sizes and climatic designations										
PNW AWWA	1962	33	67	166	Data by questionnaire					
National AWWA	1964	71	84	204	Data by questionnaire					
Porges	1957	70	80	183	Data from 1954 PHS Inventory					
Kollar & Youngwirth (Includes Calif.)	1963	86	410	191	Data from 1960 PHS Inventory					
Westgarth (Ore.)	1952	48	30	193	Data from individual city records					
Britton (Willamette)	1964	46	22	151	Data from indiv.city records					
Overall Weighted Average				187						

Climatic Designation 1 - Dry summer, winter rain 20-50 in/yr precip.
2 - Arid summer, winter snow 20 in/yr "
3 - Coastal area
4 - Pacific Northwest in total

Pacific Northwest (PNW) population 5,490,000 (Urban 3,455,000
(Non-urban 2,035,000

Design Data - Per capita use increase = 1.2 gpcd per year (1960-1980)
(Assumed for projections)= 1.0 gpcd per year (1980-2000)
= 0.8 gpcd per year (2000-2020)
Unaccounted for water = 20%
Ratio to average day = 2.0 for max. mo. and 2.7 max. day
No. of persons calculated per service = 3.35

Data for each region were ranked and plotted on arithmetic probability paper on which reasonably straight lines were formed. Estimates of standard deviations in the order of ±40 percent were obtained which show that the data do possess some hidden factors, but are acceptable for comprehensive design as long as one recognizes the high variation. Table 2 is a summary of the deviations.

TABLE 2

STANDARD DEVIATIONS OF 1960 PER CAPITA USE DATA

Climatic Designation	Mean gpcd	Standard Deviation ± gpcd	in %
1	150	56	37
2	210	88	42
3	133	52	39
4	181	75	42

For the Columbia River Basin Comprehensive Project studies the desired per capita factor is the water needed at the urban limits. Most of the data found for this study were derived from metered consumption values and so reflect use instead of need.

It was determined from a few fairly well-operated municipalities that unaccounted for water is in the order of 20 percent. This 20 percent figure was added to the 1960 use value to obtain a 1960 need value which was subsequently used as a base for projections.

Extrapolation of data is always difficult because one does not know whether to project on the same line as early data or to assume a decreasing rate. The PNW-AWWA committee plotted historical usage for 19 cities and showed for winter months a rise of about 0.7 gpcd and for summer months about 9.5 gpcd. They concluded that a one percent rise each year (about 1.7 gpcd per year) would be a reasonable estimate. Figure 1 shows their plotted data. Chronological increases for some selected cities in Figure 2 show variations from no increase to 2.4 gpcd per year. Based on these data and personal experiences of the Columbia River Basin Project staff, it was decided to use an increase of 1.2 gpcd per year for the first 20 years, 1.0 gpcd per year for the second 20 years, and 0.8 gpcd per year for the 2000 to 2020 period. It appears reasonable to assume that cities will become more stabilized, that water will be more valuable and therefore better regulated so that a decreasing rate is more realistic.

WATER USAGE FOR 19 PACIFIC NW CITIES

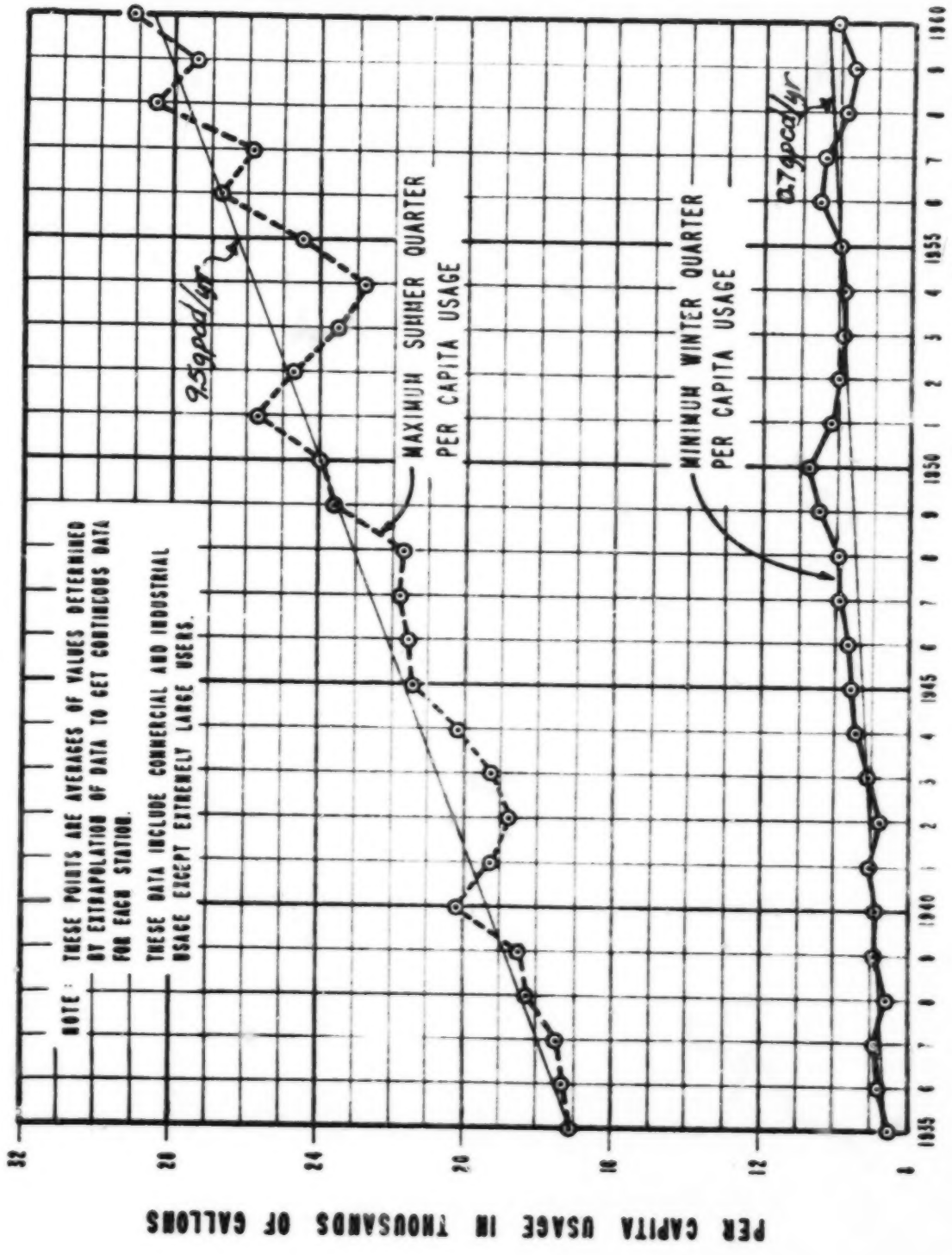

FIGURE 1

CHRONOLOGICAL PER CAPITA WATER USE VARIATION
Selected Cities in the Pacific Northwest

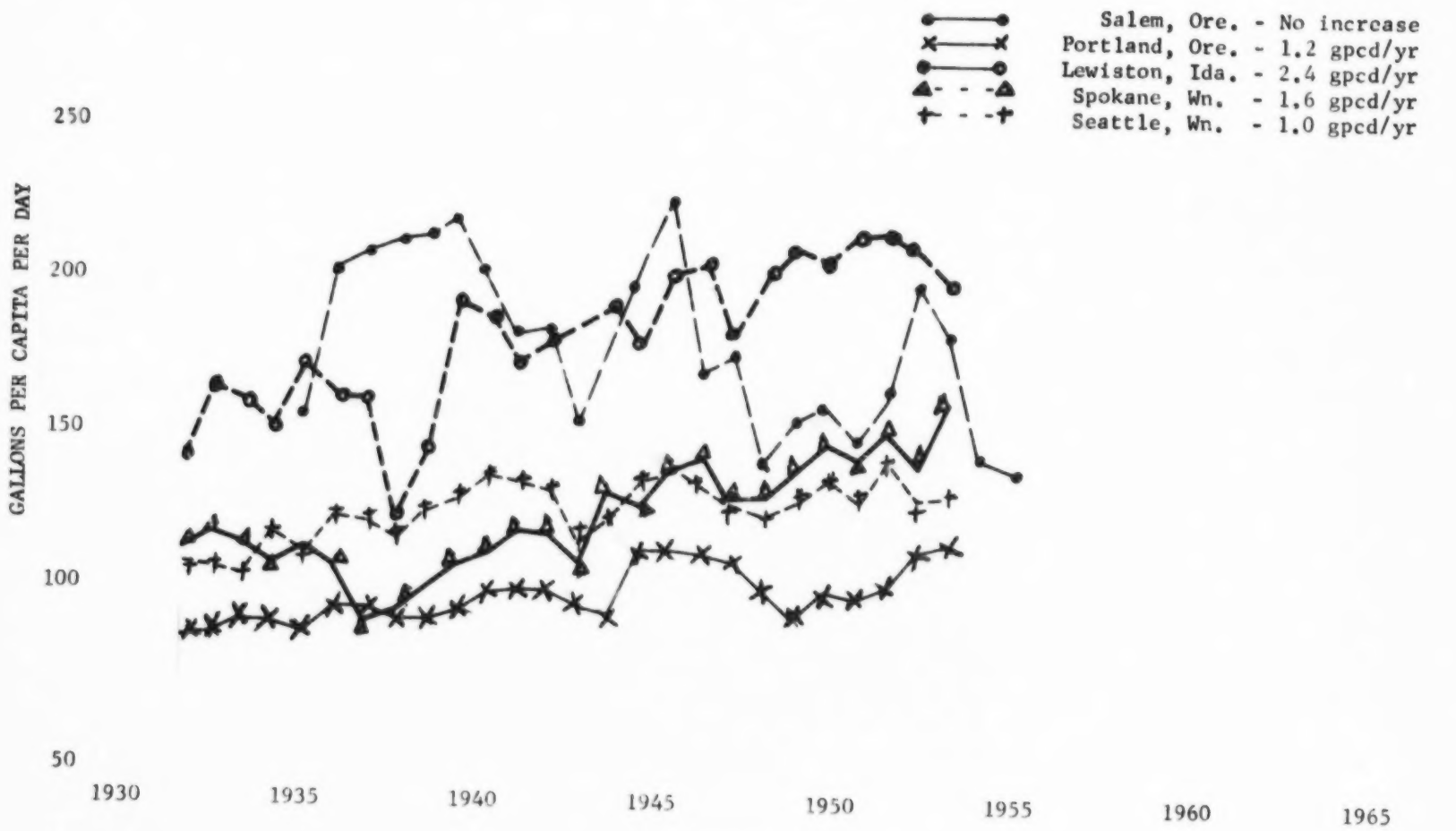

FIGURE 2

Monthly variation of need has also been considered and is shown in Table 3 for the four designations. These data show the month of July as maximum use month. June, July, August and September are all high use months.

TABLE 3

PERCENT VARIATION IN WATER NEEDS BY MONTH

Month	1	2	3	4
January	73	67	77	71
February	72	70	89	73
March	68	71	77	70
April	75	86	91	80
May	75	90	86	81
June	120	143	111	101
July	185	186	123	179
August	175	145	138	161
September	120	121	113	119
October	88	81	97	84
November	77	72	78	74
December	76	66	89	76

Now we are ready to answer the question posed at the beginning of the paper. How much water does City X, 12,000 population, Snake River require for July 2010? Looking at Table 2, the City in climatic designation 2 has a per capita need for 2010 of 290 gpcd for the average day. From Table 3 it appears that 186 percent of this value or 540 gpcd will be needed during the month of July. The total need would be (540) (31) (12,000) = 201,000,000 gallons or 6.5 mgd. The maximum day would be about (2.7) (290) (12,000) = 9.4 mgd.

In comparison with Eastern data, these values appear high, but one must remember that thunderstorm activity aids in summer irrigation in that region and that the Pacific Northwest has a drought period during which draughts are made on municipal systems for water for lawns, gardens and general cooling. This paper is designed to illustrate the differences in need and to provide reasonable facsimilies of unit needs in the Northwest.

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APPENDIX

TABLE I-1	Basic Data for Water Consumption Study for Climatic Designation 1
TABLE I-2	Basic Data for Water Consumption Study for Climatic Designation 2
TABLE I-3	Basic Data for Water Consumption Study for Climatic Designation 3
TABLE II	Data from "A Survey of Operating Data for Water Works in 1960," AWWA, 1964
TABLE III	Summary of Data for 1960 (Metered Systems) PNW AWWA Report, March 1964
TABLE IV	Willamette River Data, J. E. Britton, 1964
TABLE V	Fiscal Year 1951-52 Water Consumption Estimate for Oregon, Warren C. Westgarth, 1953

APPENDIX

TABLE I-1

BASIC DATA FOR WATER CONSUMPTION STUDY FOR CLIMATIC DESIGNATION 1

Town, State	Year	Pop.	Services	Ave.Use mgd	Ratio to Ave. Day Max.Mo.	Max.Day	Ave. gpcd
Sublimity,Ore.	1960	490					132
Oakland, Ore.	1960	865	334	0.19	0.30	0.39	220
Carlton, Ore.	1960	960					84
Mill City, Ore.	1960	1,289					75
Mt. Angel, Ore.	1960	1,428					123
Sheridan, Ore.	1960	1,763					100
Independence,Ore.	1960	1,930					147
Roberts Cr.W.D."	1960	2,100					150
Canby, Ore.	1960	2,168					185
Winston Dillard"	1960	2,250					128
Woodburn,Ore.	1960	3,120					116
Sweethome, Ore.	1960	3,353					203
West Linn, Ore.	1960	3,933					173
Gladstone, Ore.	1960	4,000					100
Gresham, Ore.	1960	4,200				1.73	179
Newberg, Ore.	1960	4,204					129
Kellogg, Idaho	1960	5,060				1.33	125
Dallas, Ore.	1960	5,072					270
Lebanon, Ore.	1960	5,858					180
Aloha Ore.	1960	7,000	1,859	0.32	0.75	2.3	46
Forest Grove,Ore.	1960	7,000	2,077	1.15	2.9	2.4	166
McMinnville,Ore.	1960	7,656	2,600	1.8	5.1	2.8	225
Oregon City,Ore.	1960	7,996					
Hillsboro, Ore.	1960	8,232					104
Centralia, Ore.	1960	9,250				3.88	123
Milwaukie, Ore.	1960	11,300	4,500	0.91			97
Albany, Ore.	1960	12,926					187
Roseburg, Ore.	1960	13,500	5,464	3.05	2.04	2.45	225
Springfield,Ore.	1960	19,616					202
Corvallis, Ore.	1960	20,667					168
Salem, Ore.	1960	50,500				2.13	185
Vancouver, Wn.	1960	52,250	14,927	6.2		2.7	123
Salem, Ore.	1960	70,000	13,368	13.1		2.61	180
Portland,Ore.	1960	373,000	123,280	151		1.3	180

TABLE I-2

BASIC DATA FOR WATER CONSUMPTION STUDY FOR
CLIMATIC DESIGNATION 2

Town, State	Year	Pop.	Services	Ave.Use mgd	Ratio to Ave. Day Max.Mo.	Max.Day	Ave. gpcd
Colburn, Idaho	1960	100					210
Helix, Ore.	1960	148	65	0.033	2.0		192
Adams, Ore.	1960	192	72	0.0165			86
Notus, Idaho	1960	324		0.05			123
Nespelem, Wn.	1960	480					212
Harrington,Wn.	1960	575					210
Wilder, Idaho	1960	603		0.08			132
Umatilla, Ore.	1960	617					425
Pateros, Wn.	1960	675					286
Huntington,Ore.	1960	690	320	0.15		3.1	218
Stanfield,Ore.	1960	745					97
Lind, Wash.	1960	800					250
Talent, Ore.	1960	900	300	0.07			75
Athena, Ore.	1960	950	362	0.51	3.02	4.42	300
Twisp, Wn.	1960	1,000					190
Plains, Mont.	1960	1,000	360	0.33			328
Mabton City, Wn.	1960	1,000		0.09			90
Grand Coulee,Wn.	1960	1,000					200
Republic, Wn.	1960	1,060					190
Brewster, Idaho	1960	1,400					236
Odessa, Wn.	1960	1,440					139
Madras, Ore.	1960	1,504	565	0.25	2.0		166
Granger, Wn.	1960	1,600		0.10			63
Oroville, Wn.	1960	1,630					245
Pilot Rock,Ore.	1960	1,695	500	0.28			165
Chelan, Wn.	1960	2,400					135
Orofino, Idaho	1960	2,500	611	0.39	1.07	2.7	156
Colfax, Wn.	1960	2,850	1,068	0.66		1.8	233
Dayton, Wn.	1960	2,890		1.05			360
Okanogan, Wn.	1960	2,900					200
Bonner's Ferry,Id	1960	2,900				4.4	172
Colville, Wn.	1960	3,000					167
Dayton, Wn.	1960	3,100					339
Prineville, Ore.	1960	3,293	1,270	0.685	2.3		105
Grangeville, Id.	1960	3,300	1,181	0.28		6.3	84
Redmond, Ore.	1960	3,492	1,273	1.45	2.3	2.8	290
Burns, Ore.	1960	3,523	1,160	2.02	3.5		560
Dillon, Mont.	1960	3,720	1,213	1.37		2.1	368
Emmett, Idaho	1960	3,767				1.50	248
Hamilton, Mont.	1960	3,800	1,034	1.59			418
Lakeview, Ore.	1960	3,850	1,400	1.03		2.9	267

TABLE I-2

(Continued)

Town, State	Year	Pop.	Services	Ave.Use mgd	Ratio to Ave. Day Max.Mo.	Max.Day	Ave. gpcd
Milton-Freewater, Ore.	1960	4,110					230
Weiser, Idaho	1960	4,200				2.13	145
Sandpoint,Idaho	1960	4,355					214
Hermiston, Ore.	1960	4,402	1,390	0.63	2.0		143
Payette, Idaho	1960	4,451	1,338	0.695	1.51		155
Ontario, Ore.	1960	5,162	1,750	1.05	1.9	2.2	203
Omak, Wn.	1960	5,500					400
Nob Hill (Yakima) Wn.	1960	6,000		0.81			134
Sunnyside, Wn.	1960	6,200		1.44			210
Glend Mont.	1960	7,043	1,759	1.2	3.8	3.2	171
Burley, Idaho	1960	7,805	2,685	2.2		1.1	282
Kellogg, Idaho	1960	8,000	2,328	1.97		1.5	247
Livingston,Mont.	1960	8,250	2,631	1.8	2.7		221
Riverton, Wyo.	1960	8,300	2,000	1.3			157
Rawlins, Wyo.	1960	8,968	2,648	1.97		2.0	220
La Grande, Ore.	1960	8,997	2,796	1.7	2.1	2.6	190
Ashland, Ore.	1960	9,120	3,300	3.4	1.9	2.2	370
East Wenatchee,Ore	1960	9,200	2,300	0.77			84
Ellensburg,Wn.	1960	9,500	2,784	2.99		2.18	300
Miles City,Mont.	1960	9,665	2,665	1.21		3.3	126
Baker, Ore.	1960	9,986	3,250	2.55	1.7	2.12	256
Mountain Home,Id.	1960	10,000		4.0			150
Grants Pass,Ore.	1960	10,118	3,840	2.28		2.8	180
Kalispell, Mont.	1960	10,151	3,819	1.82		3.3	176
Moscow, Idaho	1960	11,180		1.43	1.7-Jul	2.52	160
Clarkston, Wn.	196	12,000	3,774				
Caldwell, Idaho	1960	12,230		1.5	1.1	1.9	117
Moses Lake, Wn.	1960	12,632				3.12	256
Lewiston, Idaho	1960	12,877	4,135	2.621		4.30	203
Pullman, Wn.	1960	12,957	2,100	1.38	Jul	2.2	180
Bozeman, Mont.	1960	13,250	3,300	3.76		3.2	284
Pendleton, Ore.	1960	14,434	4,100	4.0	2.38	3.2	150
Pasco, Wn.	1960	15,200	4,001	4.82		3.15	312
Laramie, Wyo.	1960	17,500	4,800	3.84		2.7	219
Wenatchee,Wn.	1960	18,000	5,233	4.45		2.63	250
Nampa, Idaho	1960	18,013	5,880	2.0	1.2		103
Twin Falls, Id.	1960	20,162		5.8			175
Walla Walla,Wn.	1960	24,800	11,050	9.2	1.9-Jul	2.6	266
Richland, Wn.	1960	25,000	6,983	5.4	2.6	3.3	228

APPENDIX

TABLE I-2

(Continued)

Town, State	Year	Pop.	Services	Ave.Use mgd	Ratio to Ave. Day Max,Mo.	Max.Day	Ave. gpcd
Kennewick,Wn.	1960	27,000	6,280	5,1		2.6	190
Butte, Mont.	1960	27,877					186
Pocatello,Ida.	1960	28,634	6,672	7.0		2.5	243
Boise, Idaho	1960	34,482		13.7	1.6	1.8	183
Medford, Ore.	1960	34,500	11,050	9.2	1.9-Jul	2.6	266
Yakima, Wn.	1960	42,000		6.85			164
Cheyenne,Wyo.	1960	48,000	10,833	10,4		2.0	217
Spokane,Wn.	1960	181,608	54,908	68.2		2.82	164

APPENDIX

TABLE I-3

BASIC DATA FOR WATER CONSUMPTION STUDY FOR
CLIMATIC DESIGNATION 3

Town, State	Year	Pop.	Services	Ave.Use mgd	Ratio to Ave. Day Max.Mo.	Max.Day	Ave. gpcd
Ferndale, Wn.	1960	1,700	650	0.25			147
Roberts Cr. W.D. Oregon	1960	2,100		0.23	1.9		108
Winston Dillard W.D. Oregon	1960	2,250		0.29	1.94	2.8	129
Lyndon, Wash.	1960	2,800	1,260	0.32			114
Reedsport, Ore.	1960	2,998		1.3	1.58	1.61	448?
Blaine, Wash.	1960	3,200	750	0.55			172
Mt.View-Edgewood Wash.	1960	3,440				2.71	67
Coquille, Ore.	1960	4,730		0.60		3.0	126
Enumclaw,Wn.	1960	5,000	2,104	0.60		3.0	120
Shelton, Wn.	1960	6,000	2,260	1.2		1.3	200
King Co. W.D.#43 Wash.	1960	6,600	2,008	0.92			140
Anacortes, Wn.	1960	8,400		1.22	1.2		145
Centralia, Wn.	1960	9,250	4,000	1.65		1.4	178
Hoquiam, Wn.	1960	10,762					87
Edmonds, Wn.	1960	11,500	3,600	0.93			81
Mountlake Terrace Wash.	1960	11,500	3,150				88
Astoria, Ore.	1960	11,840	3,201	3.56	1.5		301
Auburn, Wn.	1960	13,761				3.08	95(110)
King Co. W.D. #68 Wash.	1960	18,860	5,388			5.34	63
Skagit Co.PUD #1, Wash.	1960	22,123	7,375	4.3		2.3	193
Coos Bay, Ore.	1960	21,257	4,977	2.99		1.7	141
Bellevue, Wn.	1960	24,000					(125)
Longview, Wn.	1960	24,000	7,775			2.54	81(99)
King Co.W.D.#20, Wash.	24,170					3.42	107
Renton, Wash.	1960	24,500	6,468				330
Lakewood W.D.,Wn	1960	35,000				7.05	81
Bremerton, Wn.	1960	41,000	11,234			2.57	135(85)
Frot Lewis, Wn.	1960	45,000					150
Alderwood Manor W.D.,Wash.	1960	50,400	11,052	3.947	2.5	5.1	78
Tacoma, Wash.	1960	156,300	44,378	48.8		2.29	160
Seattle, Wn.	1960	561,000	153,957	98.5		2.69	134

APPENDIX
TABLE II

DATA FROM "A SURVEY OF OPERATING DATA FOR WATER WORKS IN 1960"
AWWA 1964

AWWA No.	City or District	State	Pop. Served	Million Gal. Produced	Ave. Daily Production mgd	Max.Day mgd	Max.Hr. mgd	No. of Services	% Metered	gpcd	gpcd Other Source	Max.Day Ave.Day	Max Hr. Ave.Day	Persons/ Services
14	Alderwood Manor W.D.	Wash.	50,400	1,441	3.947	10.000	20.000	11,052	---	78		2.5	5.1	4.56
46	Astoria	Ore.	11,840	1,300	3.561	5.470	---	3,201	100	301		1.5	---	3.70
71	Bellevue (King Cty. W.D. #68)	Wash.	18,500	794	---	7.600	9.000	5,388	100	---	63	---	---	3.44
72	Bellingham	Wash.	38,558	17,819	48.820	74.000	---	12,232	9	266	242	1.5	---	3.15
89	Boise	Ida.	63,000	3,219	---	23.000	---	17,667	100	---	183	---	---	3.57
93	Bozeman	Mont.	13,250	1,374	3.764	12.000	---	3,300	---	284		3.2	---	4.02
97	Bremerton	Wash.	41,000	2,022	5.539	13.360	21.500	11,234	---	135	85	2.4	3.9	3.65
115	Caldwell	Ida.	12,400	570	1.561	2.600	---	3,250	100	126	117	1.7	---	3.82
141	Cheyenne	Wyo.	48,000	3,793	10.392	20.840	39.590	10,833	---	217		2.0	3.8	4.45
150	Clarkston	Wash.	12,000	---	---	26.000	40.000	3,774	100	---		---	---	3.18
160	Coeur d'Alene	Ida.	17,000	1,486	4.071	---	---	4,968	11	230	250	---	---	3.42
175	Coos Bay	Ore.	21,257	1,093	2.993	5.200	---	4,977	100	141		1.7	---	4.27
222	Edmonds	Wash.	11,500	340	0.931	---	---	3,600	---	81		---	---	3.20
238	Eugene	Ore.	70,800	4,777	13.073	34.560	58.000	13,368	100	185		2.6	4.4	5.28
291	Grants Pass	Ore.	10,500	630	1.726	6.000	---	3,727	100	164	180	3.5	---	2.82
293	Great Falls	Mont.	67,000	4,764	13.052	38.000	.000	13,884	4	195		2.9	4.0	4.82
339	Idaho Falls	Ida.	33,160	4,968	13.610	22.300	37.700	9,588	0	410	(270) 384	1.6	2.8	3.45
363	Kalispell	Mont.	12,000	669	1.832	6.000	---	3,819	---	153	176	3.3	---	3.15
375	Kennewick	Wash.	27,000	1,874	5.134	13.500	26.400	6,280	---	190		2.6	5.1	4.30
398	Laramie	Wyo.	17,500	1,401	3.838	10.300	---	4,800	---	219		2.7	---	3.65
409	Lewiston	Ida.	13,000	1,068	2.926	10.000	25.000	4,184	100	225	203	3.4	8.5	3.11
425	Longview	Wash.	30,100	1,031	2.824	9.200	---	7,875	100	94	(99) 81	3.2	---	3.83
461	Medford	Ore.	34,852	3,357	9.197	22.340	36.800	8,380	56	264	266	2.4	4.0	4.16
501	Mountlake Terrace	Wash.	11,500	272	---	2.000	---	3,150	100	---		---	---	3.65
510	Nampa	Ida.	18,000	700	1.917	---	---	5,880	---	107	103	---	---	3.06

APPENDIX
TABLE II

(Continued)

AWWA No.	City or District	State	Pop. Served	Million Gal. Produced	Ave. Daily Production	Max.Day mgd	Max.Hr. mgd	No. of Services	% Metered	gpcd	gpcd Other Source	Max.Day Ave.Day	Max.Hr. Ave.Day	Persons/ Service
560	Olympia,	Wash.	21,789	1,001	7.500	---	---	6,202	---	---		---	---	3.50
561	Olympic View W.D.	Wash.	10,000	---	---	---	---	3,684	---	---		---	---	2.72
582	Pasco	Wash.	15,000	1,758	4.816	14.500	16.000	4,001	100	321	312	3.0	3.3	3.75
584	Pendleton	Ore.	15,500	1,835	5.027	12.000	---	3,992	---	324	150	2.4	---	3.88
596	Pocatello	Ida.	28,634	2,558	7.008	17.400	40.000	6,672	100	243		2.5	5.7	4.30
601	Port Angeles	Wash.	12,500	1,454	3.983	9.000	12.000	---	---	319	272	2.3	3.0	---
605	Portland	Ore.	551,700	55,166	151.139	190.000	---	123,280	100	274	180	1.3	---	4.50
613	Puyallup	Wash.	12,000	---	2.400	---	---	4,350	---	---		---	---	2.76
624	Renton	Wash.	24,807	1,346	---	7.500	---	6,468	100	---	330	---	---	3.84
625	Richland	Wash.	23,549	4,191	---	34.100	50.850	6,983	100	---	228	---	---	3.37
634	Rock Springs	Wyo.	13,857	1,016	---	4.000	---	4,371	---	---		---	---	3.18
639	Roseburg	Ore.	18,100	1,113	3.049	7.500	10.000	5,769	100	168	225	2.5	3.3	3.12
650	Salem	Ore.	56,926	4,163	11.405	27.700	47.000	13,844	100	200	185	2.4	4.1	4.10
675	Seattle	Wash.	734,779	35,948	98.488	264.000	665.280	153,957	---	134	134	2.7	6.7	4.78
690	Skagit Co. PUD #1	Wash.	22,123	1,560	4.273	10.000	---	7,375	100	193		2.3	---	3.00
699	Spokane	Wash.	190,000	24,911	68.249	156.000	240.000	54,908	100	359	164	2.3	3.5	3.47
719	Tacoma	Wash.	157,000	17,824	48.832	79.000	102.000	44,378	100	311	160	1.6	2.1	3.55
774	Wenatchee	Wash.	17,000	1,625	4.452	11.487	---	5,233	100	262	250	2.6	---	3.24
799	Wolf Creek Hwy. W.D.	Ore.	15,000	---	---	4.000	---	3,808	100	---		---	---	3.94
1004	Aloha	Ore.	7,000	117	0.320	0.750	---	1,859		46		2.3	---	3.76
1008	Anacortes	Wash.	9,400	5,767	15.800	21.000	---	3,062		681		1.3	---	3.06
1018	Baker	Ore.	9,986	858	2.349	5.570	8.570	3,380		235	256	2.4	3.7	2.95
1029	Beaverton	Ore.	8,000	2,354	6.451	---	---	2,400		806		---	---	3.34
1047	Burley	Ida.	7,805	804	2.202	2.300	---	2,685		282		1.1	---	2.91
1048	Burns	Ore.	3,700	595	1.630	1.870	3.700	1,100	---	441	560	1.1	2.3	3.36
1080	Colfax	Wash.	2,855	243	0.664	1.183	---	1,068	---	233	233	1.8	---	2.67
1084	Coquille	Ore.	4,730	218	0.597	1.800	---	1,578	---	126		3.0	---	3.00
1098	Dillon	Mont.	3,720	500	1.369	2.800	---	1,213	---	368		2.1	---	3.08

APPENDIX
TABLE II

(Continued)

AWWA No.	City or District	State	Pop. Served	Million Gal. Produced	Ave.Daily Production	Max.Day mgd	Max.Hr. mgd	No. of Services	% Metered	gpcd	gpcd Other Source	Max.Day Ave.Day	Max.Hr. Ave.Day	Persons/ Service
1113	East Wenatchee	Wash.	9,200	281	0.769	---	---	2,300	---	84		---	---	4.00
1117	Ellensburg	Wash.	9,000	984	2.695	5.970	11.600	2,784	---	299		2.2	4.3	3.23
1120	Enumclaw	Wash.	5,000	219	0.600	1.300	2.500	2,104	---	120		3.0	4.2	2.37
1132	Federal Way	Wash.	5,200	100	---	1.000	---	1,300	---	---		---	---	4.00
1135	Forest Grove	Ore.	7,000	421	1.153	2.900	4.500	2,077	---	165		2.4	3.9	3.38
1150	Glasgow	Mont.	7,000	295	---	2.000	---	1,635	---	---		---	---	4.27
1151	Glendive	Mont.	7,043	439	1.202	3.800	6.000	1,759	---	171		3.2	5.0	4.00
1156	Grangeville	Ida.	3,300	101	0.276	1.750	2.000	1,181	---	84		6.3	7.2	2.79
1167	Hamilton	Mont.	3,800	580	1.589	---	---	1,034	---	418		---	---	3.68
1209	Juneau	Alask.	7,313	1,050	2.876	3.900	10.000	1,100	---	393		1.4	3.5	6.66
1210	Kellogg	Ida.	8,000	720	1.972	3.000	---	2,328	---	247		1.5	---	3.36
1211	Ketchikan	Alask.	6,922	2,264	6.202	7.300	---	2,371	---	896		1.2	---	2.48
1215	King Co. W. D. #43	Wash.	6,600	337	0.923	---	---	2,008	---	140		---	---	3.30
1216	King Co. W. D. #93	Wash.	8,400	243	0.664	---	---	2,178	---	79		---	---	3.86
1217	Kirkland	Wash.	7,650	---	---	---	---	2,786	---	---		---	---	2.74
1221	La Grande	Ore.	9,196	626	1.715	4.360	6.900	3,239	---	186	190	2.5	4.0	2.83
1225	Lakeview	Ore.	3,850	375	1.027	3.000	---	1,400	---	267		2.9	---	2.76
1245	Livingston	Mont.	8,250	666	1.824	5.000	---	2,631	---	221		2.7	---	3.14
1261	McMicken Heights	Wash.	4,856	70	---	---	---	1,550	---	---		---	---	3.14
1262	McMinnville	Ore.	7,600	660	1.808	---	---	2,600	---	238	225	---	---	2.93
1269	Miles City	Mont.	9,665	443	1,213	4.000	4.500	2,665	---	126		3.3	3.7	3.62
1270	Milwaukie	Ore.	9,099	332	0.909	---	---	4,500	---	100	97	---	---	2.02
1302	Ontario	Ore.	5,000	353	0.967	2.500	3.750	1,595	---	193	203	2.6	3.9	3.14
1307	Orifino	Ida.	2,500	143	0.391	1.070	1.440	611	---	156		2.7	3.7	4.08
1325	Plains	Mont.	1,000	120	0.328	---	---	360	---	328		---	---	2.78
1335	Prineville	Ore.	3,800	274	0.751	---	---	1,231	---	198	105	---	---	3.08
1345	Rawlins	Wyo.	8,968	720	1.972	4.000	---	2,648	---	220		2.0	---	3.38
1355	Riverton	Wyo.	8,300	476	1.304	---	---	2,000	---	157		---	---	4.15
1371	Shelton	Wash.	6,000	438	1.200	1.500	---	2,260	---	200		1.3	---	2.66
	Total		2,891,089											
	Average									204		2.4	4.2	3.5

APPENDIX
TABLE III

SUMMARY OF DATA FOR 1960

(Metered Systems)

PNW AWWA REPORT, MARCH 1964

System or City	Average Annual Temp °F.	Average Annual Precip in.	Avg. Annual Per Cap. Demand (gpcd)	RATIOS		
				Max Day to Avg Day	Max Hr to Max Day	
Portland 551,700	54.0	44.38	118	N.A.		WESTERN ORE.
Gresham 4,200	51.7	47.5	158	1.73		
Salem 56,930	51.8	41.1	186	2.13	1.90	
Eugene * 70,800	52.6	32.94	168	2.61	1.77	
Vancouver 52,250	52.4	39.4	123	3.09		WESTERN WASHINGTON
Olympia 21,790	49.4	50.45	133	2.46		
Longview 30,100	51.4	46.7	81	2.54		
Lakewood Water Dist. (Tacoma) 35,000	51.2	35.2	81	7.05	1.28	
Hoquiam 10,762	50.3	70.31	87	N.A.		
Auburn 13,761	50.2 (Used Kent, Auburn Not Given)	40	95	3.08	2.04	
Centralia 9250	50.3	50.74	123	3.88	1.44	
Mt. View-Edgewood 3440	49.5 (Bellingham Airport)	34.75	67	2.71		
Tacoma 157,000	51.2	35.2	160	2.29	1.41	
Bremerton 41,000	51.0	51.13	85	2.57		
Seattle 734,779	53.2	36.6	134	2.69	2.52	
King Co. Water Dist's.						
#20 24,170	53	40 (Est.)	63	5.34	3.0	
#68 18,860	53	40 (Est.)	107	3.42		
Avg. Western Ore. & Wash.			116	3.17	1.92	

* 1959 Data

Source: PNW AWWA Report March, 1964

APPENDIX
TABLE III

SUMMARY OF DATA FOR 1960 (Cont'd)
(Metered Systems)

System or City	Average Annual Temp °F.	Average Annual Precip. in.	Avg. Annual Per Capita Demand (gpcd)	RATIOS		
				Max Day to Avg Day	Max Hr to Max Day	
Wenatchee 17,000	50.4	7.99	250	2.63		EASTERN WASHINGTON
Pasco 15,000	53.1	6.5	312	3.15	1.02	
Spokane 190,000	49.3	18.69	164	2.82	2.73	
Colfax 2855	47.5	19.66	233	3.73		
Moses Lake 12,622	48.6	8.14	256	3.12		
Richland 23,549	54	6.31	425	2.89	1.59	
Vera Irrigation District #15 40,000 ?	50	19 (Spokane Data)				
Ellensburg 9,000	47.1	8.05	300	2.18	2.04	
Avg. Eastern Washington			277	3.35	1.85	
Kellogg 8,000	46.5	29.56	125	1.33		IDAHO
Moscow 11,180	48.0	21.44	103	2.52	1.82	
Weiser 4200	50.1	10.33	145	2.13		
Bonners Ferry 2900	45.5	23.29	172	4.4		
Caldwell 12,230	51.8	10.8	66	1.59		
Emmett 3767	50.0	13.06	248	1.50		
Avg. Idaho			143	2.25	1.82	
Everett 87,028	50.2	34.15	178			UNMETERED SYSTEMS
Port Angeles 12,653	49.3	22.94	272	2.54		
Coeur d' Alene 15,570	47.7	26.43	250	3.9	1.53	

2,303,341 Total population represented

Source: PNW AWWA Report March, 1964

APPENDIX
TABLE IV

WILLAMETTE RIVER DATA
J. E. Britton, 1964

	Population	gpcd
Eugene	92,500	183
Springfield (PP&L)	12,000	202
" UB	8,000	111
Junction City	1,600	288
Cottage Grove	5,000	200
Oakridge	4,000	375
Monroe	450	94
Albany	13,000	187
Corvallis	24,000	168
Dallas	7,000	212
Dundee	500	157
Independence	2,100	147
Newberg	5,500	129
Sublimity	400	132
Salem	78,600	161
Lebanon	6,000	180
Mill City	1,500	75
Stayton	2,500	295
Sweet Home	3,400	203
Amity	700	55
Carlton	1,000	84
Dayton	800	142
Eola Village	1,000	84
Lafayette	600	140
McMinnville	8,300	225
Sheridan	2,000	100
Willamina	1,000	260
Yamhill	1,200	217
Mt. Angel	1,500	123
Woodburn	4,000	116
Canby	2,200	185
Portland	386,000	180
Gresham	5,000	162
Tigard W.D.	3,000	96
Clackamas W.D.	9,000	83
Gladstone	4,000	100
Milwaukie	11,300	97
Lake Oswego	12,000	92
Troutdale	600	71
Richland	2,600	105
Estacada	1,200	225
Forest Grove	7,000	166
Hillsboro	18,500	104
Cornelius	1,400	121
Gaston	500	60
Aloha-Huber W.D.	3,500	63
46 Cities	757,950	151

APPENDIX
TABLE V

FISCAL YEAR 1951-52 WATER CONSUMPTION ESTIMATE FOR OREGON
Warren C. Westgarth, 1953

Size Range	City	Population 1950 Census	Total Customers	% Metered (Approx) Residential	Per Capita Ave. Year	Consumption Max Month	Max Month Divided by Ave Yr
Over 50,000	Portland	373,628	148,521	100	185	---	---
25,000-50,000	Eugene	35,879	14,450	100	227	405	1.78
	Salem	43,140	13,375	100	172	370	2.15
10,000-25,000	Albany	10,115	3,246	95	218	359	1.65
	Corvallis	16,207	4,498	100	125	211	1.69
	Springfield	10,807	3,348	5	305	568	1.87
5,000-	Hillsboro	5,142	4,710	100	304	476	1.57
	Lebanon	5,873	1,942	25	286	585	2.04
	McMinnville	6,635	2,250	98	198	376	1.90
	Milwaukie	5,253	1,550	100	---	---	---
	Oregon City	7,682	2,903	30	248	344	1.39
2,500-5,000	Dallas	4,793	1,900	100	271	388	1.43
	Forest Grove	4,343	1,580	99	169	331	1.96
	Gresham	3,049	1,181	100	99	168	1.70
	Newberg	3,946	1,803	100	146	282	1.93
	Sweet Home	3,603	1,135	100	183	272	1.49
	West Linn	2,945	1,100	30	214	287	1.34

APPENDEX
TABLE V

(Continued)

Size Range	City	Population 1950 Census	Total Customers	% Metered (Approx) Residential	Per Capita Consumption Ave. Year	Max Month	Max Month Divided by Ave Yr
1,000-2,500	Canby	1,671	674	100	112	258	2.30
	Carlton	1,081	442	95	107	190	1.78
	Gladstone	2,434	963	100	679	1,030	1.52
	Independence	1,987	650	95	156	294	1.88
	Mill City	1,792	509	95	160	253	1.58
	Mt. Angel	1,315	418	90	110	218	1.98
	Sheridan	1,922	770	90	106	203	1.94
	Woodburn	2,395	1,100	100	126	307	2.50
500-1,000	Creswell	662	293	99	66	103	1.56
	Turner	610	191	100	134	237	1.77
0-500	Columbia City	405	113	100	57	117	2.05
	Sublimity	367	86	100	80	114	1.43
10,000-25,000	Astoria	12,331	6,500	100	210	289	1.38
5,000-10,000	Coos Bay-North Bend	12,322	4,687	100	164	190	1.16
2,500-5,000	Newport	3,241	1,400	100	144	206	1.43
1,000-2,500	Florence	1,026	340	100	48	49	1.02
500-1,000	Eastside	890	272	95	469	655	1.40
	Gearhart	568	493	55	134	324	2.42

APPENDIX
TABLE V

(Continued)

Size Range	City	Population 1950 Census	Total Customers	% Metered (Approx) Residential	Per Capita Consumption Ave Year	Max Month	Max Month Divided by Ave Yr
	SOUTH						
10,000-25,000	Klamath Falls	15,875	7,938	100	252	470	1.87
	Medford	17,305	7,622	4	428	645	1.51
5,000-10,000	Ashland	7,739	2,649	---	276	587	2.13
	Grants Pass	8,116	3,230	100	171	334	1.96
	Roseburg	8,390	4,296	100	248	450	1.82
1,000-2,500	Central Point	1,667	540	100	129	248	1.92
	Myrtle Creek	1,781	627	98	1,570	1,770	1.13
500-1,000	Merrill	835	244	68	114	211	1.85
	CENTRAL and EASTERN						
10,000-25,000	Bend	11,409	3,681	0	242	462	1.91
	Pendleton	12,218*	3,458	100	---	---	---
5,000-10,000	Baker	9,471	3,140	97	---	580	---
	La Grande	8,635	2,536	100	233	435	1.87
	The Dalles	6,676	3,030	0	670	970	1.45
2,500-5,000	Ontario	4,465	1,402	100	116	194	1.67
	Prineville	3,233	1,055	---	110	---	---
	Redmond	2,956	1,193	3	342	710	2.08
0-500	Boardman	120	62	89	107	188	1.76
	Wasco	305	126	100	116	121	1.04

* Special count by Secretary of State